#4

Atty. Dkt. No. 085874/0193

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Neil HARRIS et al.

Title: LOUDSPEAKERS

Appl. No.: 09/435,354

Filing Date: 11/08/1999

Examiner: Unassigned

Art Unit: 2743

CLAIM FOR CONVENTION PRIORITY

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

The benefit of the filing date of the following prior foreign applications filed in the following foreign country is hereby requested, and the right of priority provided in 35 U.S.C. § 119 is hereby claimed.

In support of this claim, filed herewith are certified copies of said original foreign applications:

- United Kingdom Patent Application No. 9824255.5 filed November 6, 1998.
- United Kingdom Patent Application No. 9914410.7 filed June 22, 1999.

Respectfully submitted,

Date January 14, 2000

By _____

Alan I. Cantor
Attorney for Applicant
Registration No. 28,163

FOLEY & LARDNER
Washington Harbour
3000 K Street, N.W., Suite 500
Washington, D.C. 20007-5109
Telephone: (202) 672-5570
Facsimile: (202) 672-5399

The Patent Office

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely [illegible] the company to certain additional company law rules.

Signed

Dated - 9 NOV 1999

CERTIFIED COPY OF PRIORITY DOCUMENT

Patents Form 1/77

Patents Act 1977
(Rule 16)

6 NOV 1998

THE PATENT OFFICE
C
-6 NOV 1998
RECEIVED BY POST

The Patent Office

06NOV98 E402688-1 D02824
P01/7700 0.00 - 9824255.5

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form).

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

1. Your Reference

P.5854

2. Patent application number
(The Patent Office will fill in this part)

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

NEW TRANSDUCERS LIMITED
Stonehill
Huntingdon
Cambridgeshire
PE18 6ED
G.B.

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

G.B.

07133119003

4. Title of the invention

LOUDSPEAKERS

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

MAGUIRE BOSS
5 Crown Street
St. Ives
Cambridgeshire
PE17 4EB

Patents ADP number *(if you know it)*

00009191002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day/month/year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day/month/year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body:)
See note (d)

Yes

following items you are filing with this form.
Do not count copies of the same document

Continuation sheets of this form	
Description	8
Claims(s)	2
Abstract	1
Drawing(s)	4 + 4

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature Date 05 /11 /98

MAGUIRE BOSS

12. Name and daytime telephone number of person to contact in the United Kingdom **P.A. MAGUIRE** Tel: 01480 301588

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.

b) Write your answers in capital letters using black ink or you may type them.

c) If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.

d) If you have answered 'Yes' Patents Form 7/77 will need to be filed.

e) Once you have filled in the form you must remember to sign and date it.

f) For details of the fee and ways to pay please contact the Patent Office.

TITLE: LOUDSPEAKERS

DESCRIPTION

The invention relates to loudspeakers and more particularly to resonant panel-form loudspeakers of the kind disclosed in International patent application WO97/09842 of New Transducers Ltd. Such resonant panel-form loudspeakers may comprise a member having capability to sustain and propagate input vibrational energy by bending waves in at least one operative area extending transversely of thickness to have resonant mode vibration components distributed over said at least one area and have predetermined preferential locations or sites within said area for transducer means and having a transducer mounted on said member at one of said locations or sites to vibrate the member to cause it to resonant forming an acoustic radiator which provides a diffuse acoustic output when

resonating.

A resonant panel-form loudspeaker of this kind is characterised by a large area, low intensity diffuse source with an almost spherical acoustic radiation. In some applications this wide directivity might be a problem and method of control might be advantageous in such cases.

It is known that horn loading of a pistonic loudspeaker driver may improve the acoustic impedance between the small vibrating diaphragm of the loudspeaker drive and the surrounding air, resulting in increased efficiency and controlled directivity. Such a horn behaves as an acoustic transformer by allowing the sound waves created by the diaphragm to expand in a controlled fashion along its length.

It is an object of the invention to assist in controlling the directivity of the acoustic radiation from a resonant panel loudspeaker.

It is a further object of the invention to improve the acoustic gain of a resonant panel loudspeaker in an intended direction(s).

From one aspect the invention is a loudspeaker comprising a member having capability to sustain and propagate input vibrational energy by bending waves in at least one operative area extending transversely of thickness to have resonant mode vibration components distributed over said at least one area and have predetermined preferential locations or sites within said area for transducer means and having a transducer mounted

on said member at one of said locations or sites to vibrate the member to cause it to resonate forming an acoustic radiator which provides an acoustic output when resonating, and a horn mounted to the radiator to direct the output.

From another aspect the invention is a loudspeaker comprising a member having capability to sustain and propagate input vibrational energy by bending waves in at least one operative area extending transversely of thickness to have resonant mode vibration components distributed over said at least one area and have predetermined preferential locations or sites within said area for transducer means and having a transducer mounted on said member at one of said locations or sites to vibrate the member to cause it to resonate forming an acoustic radiator which provides an acoustic output when resonating, and a horn mounted to the radiator to direct the output.

The horn is preferably mounted to the radiator using a compliant suspension.

The radiator may be mounted at the throat of the horn, and the rear radiated sound absorbed in a closed chamber. This chamber may have acoustically absorbing material added to dampen acoustic resonances.

The horn may be a double horn comprising coaxial inner and outer horns. This enables the rear radiation to be ducted to the front and the two sources of sound to be summed.

The horn may have an outwardly directed lip around the circumference of its end open to the air. Such a lip may

help to reduce diffraction effects by softening the edge between the horn and the air.

The radiator may be curved. The advantage of a curved panel is that the curvature of the panel can be adjusted so that the initial wavefront radiating from the panel matches the geometry of the horn.

The horn may include veins or perforations to provide a means to reduce resonances in the throat of the horn.

The horn may be of the barn-door type, comprising four generally trapezoidal plates, and a frame attached to one edge of each plate so as to form a truncated pyramid-like structure having opposed open ends. The radiator may be mounted to the frame of the barn-door type horn. The generally trapezoidal plates may be pivotally attached to the frame of the barn-door type horn to permit adjustment of the operating angle between the planes of the plates and the plane of the radiator. Increasing the operating angle increases the effective size of the radiation area of the resonant panel and thus adjusts its directivity. Thus a pivotal attachment between the frame of the barn-door type horn and the plates permits greater flexibility in controlling the directionality of the acoustic radiation.

There are two important ways in which the nature of the radiation of a radiator as described above may improve the performance of a horn as compared with a horn-loaded conventional pistonic loudspeaker driver. In a conventional pistonic loudspeaker driver, the sound waves are produced by a small vibrating diaphragm. The best

results are produced in a horn with a narrow neck connected to the diaphragm and a flared end open to the air. Such a horn behaves as an acoustic transformer by allowing the sound waves created by the diaphragm to expand in a controlled fashion along its length. In a resonant panel radiator, the initial wavefront can be much larger than that of a diaphragm in a conventional pistonic driver which permits a small compression ratio to be used in the horn; thus distortion may be reduced. In particular, the long neck of a conventional loudspeaker horn may be unnecessary for the horn of a resonant panel loudspeaker.

The resonant panel radiator as described also produces a diffuse source, which may also suppress or prevent standing waves in the horn throat.

The invention is diagrammatically illustrated, by way of example, in the accompanying drawings in which:-

Figure 1 is a cross-section of a basic horn;

Figure 2 is a cross-section of a double horn;

Figure 3 is a cross-section of a another double horn;

Figure 4 is a cross-section of a lipped horn;

Figure 5 is a cross-section of a further horn;

Figure 6 is a schematic view of barn-door type horn, and

Figure 7 is a scrap cross-sectional view showing the mounting of a resonant panel drive unit in a horn.

Figure 1 illustrates a horn (1) mounted to a resonant panel acoustic radiator (2), the radiator being of the kind disclosed in International patent application WO97/09842,

to direct the output from the acoustic radiator. Such a radiator (2) may comprise a member having capability to sustain and propagate input vibrational energy by bending waves in at least one operative area extending transversely of thickness to have resonant mode vibration components distributed over said at least one area and have predetermined preferential locations or sites within said area for transducer means and having a transducer mounted on said member at one of said locations or sites to vibrate the member to cause it to resonate forming an acoustic radiator which provides an acoustic output when resonating.

The radiator (2) is mounted to the inside of the horn (1) using a compliant suspension, see Figure 7. Between the radiator (2) and an inner end of the horn (1) there is a closed rear cavity (3), which can be used to absorb the rear acoustic output whereby radiation from the rear side of the radiator is contained within the rear cavity (3). Acoustic wadding (19) may fill the cavity (3). The arrows (11) indicate the direction of radiation from the acoustic radiator.

In Figure 2 another embodiment of the invention is illustrated. A double horn (4) comprising coaxial inner (5) and outer (6) horns is mounted to a radiator (2) of the kind disclosed in International patent application WO97/09842. The radiator (2) is connected to one end of the inner horn (5) in such a manner to allow the rear radiation to couple to the outer horn (6) by means of a rear cavity (3). The sound waves from the rear side of the

panel (2) radiate along the duct (7) formed between the inner horn (5) and outer horn (6) to the mouth of the duct (7) as indicated by the arrows (11).

In Figure 3, a second embodiment of double horn (4) is mounted to a radiator (2) of the kind disclosed in WO97/09842. The double horn comprises coaxial inner and outer horns (5,6). In this embodiment the radiator (2) is mounted directly to the outer horn (6), e.g. as shown in Figure 7 below, and is formed with at least one hole (16), which couples the rear cavity (3) to the throat of the inner horn (5). As the arrows (11) indicate, the sound waves from the rear side of the panel (2) circulate behind the radiator (2) and pass through the hole (16) in the panel into the inner horn (5).

In Figure 4, there is illustrated an embodiment of horn loaded resonant panel loudspeaker in which the horn (1) has an outwardly directed lip (8) along the circumference of its flared end. Such a lip (8) may help to reduce diffraction effects by softening the edge between the horn (1) and the air. In this embodiment a resonant panel radiator (9) of the kind disclosed in International patent application WO97/09842 is of a curved form such that its convex face is disposed towards the flared end of the horn. The advantage of a curved panel (9) is that the curvature of the panel (9) can be adjusted so the initial wavefront radiating from the panel (9) matches the geometry of the horn.

In Figure 5, there is shown an embodiment of horn

loaded resonant panel radiator loudspeaker generally of the kind shown in Figure 2 and in which veins (10) or perforations are incorporated into the horn (1) to provide a means to reduce air resonances in the throat of the horn (1).

Figure 6 illustrates a loudspeaker comprising 'barn-door' type horn (12) mounted on a resonant panel acoustic radiator (2) of the kind disclosed in International patent application WO97/09842. The horn is constructed from substantially trapezoidal plates (13) which are connected to a frame (14) by hinges (15) to form a four sided truncated pyramid-like structure. The frame is then mounted to the resonant radiator (2) by means of a compliant suspension, see Figure 7. Thus the plates can be hinged on the frame to adjust the flare of the horn and the directivity of the loudspeaker.

In Figure 7 there is shown a partial cross-section of a loudspeaker horn (4) having an inwardly directed flange (17) which carries a resilient suspension (18) e.g. of a rubber-like material which is bonded to a face of the resonant panel acoustic radiator (2) at suitable locations to support the panel in position in the horn.

This invention thus provides apparatus for controlling the directivity of a loudspeaker comprising a resonant panel by mounting a horn to the radiator. Such apparatus may also improve the acoustic gain of the loudspeaker in the intended directions.

CLAIMS

1. A loudspeaker comprising a resonant acoustic radiator and a horn mounted to the radiator to direct the acoustic output of the radiator.

2. A loudspeaker comprising a member having capability to sustain and propagate input vibrational energy by bending waves in at least one operative area extending transversely of thickness to have resonant mode vibration components distributed over said at least one area and have predetermined preferential locations or sites within said area for transducer means and having a transducer mounted on said member at one of said locations or sites to vibrate the member to cause it to resonate forming an acoustic radiator which provides an acoustic output when resonating, and a horn mounted to the radiator to direct the output.

3. Loudspeaker according claim 1 or claim 2, wherein the horn is mounted to the radiator using a compliant suspension.

4. Loudspeaker according to any one of claims 1 to 3, wherein a closed cavity is provided to one side of the radiator.

5. Loudspeaker according to any one of claims 1 to 3, wherein the horn comprises coaxial inner and outer horns.

6. Loudspeaker according to any preceding claim, wherein the horn is terminated by an outwardly directed lip around the circumference of its end open to the air.

7. Loudspeaker according to any preceding claim, wherein the radiator is panel-form and is curved.

8. Loudspeaker according to claim 7, wherein the radiator is convexly curved in a direction towards the horn mouth.

9. Loudspeaker according to any preceding claim, wherein the horn comprises veins or perforations.

10. Loudspeaker according to any one of claims 1 to 3 or 7, wherein the horn comprises a plurality of generally trapezoidal plates and a frame attached to one edge of each plate so as to form a truncated pyramid-like structure having opposed open ends.

11. Loudspeaker according to claim 10, wherein the radiator is mounted to the frame.

12. Loudspeaker according to claim 11, wherein the plates are pivotally attached to the frame.

ABSTRACT

TITLE: LOUDSPEAKERS

Apparatus for controlling the directivity of a radiator in a resonant panel-form loudspeaker by mounting a horn to the radiator.

(Fig.1)

Fig. 1

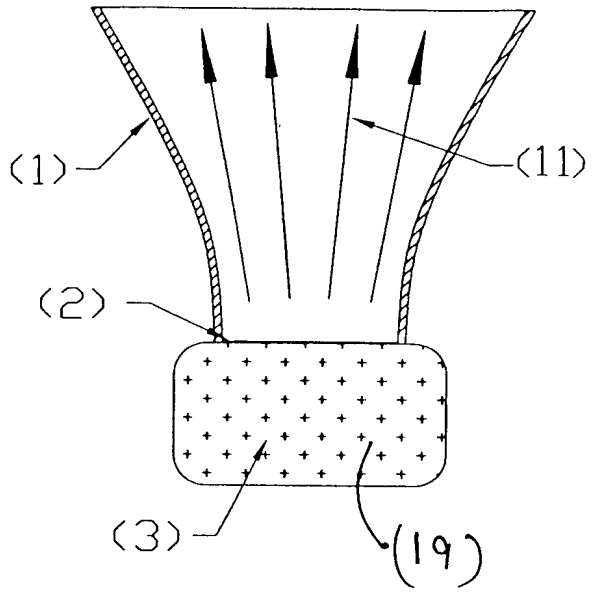

Fig 2

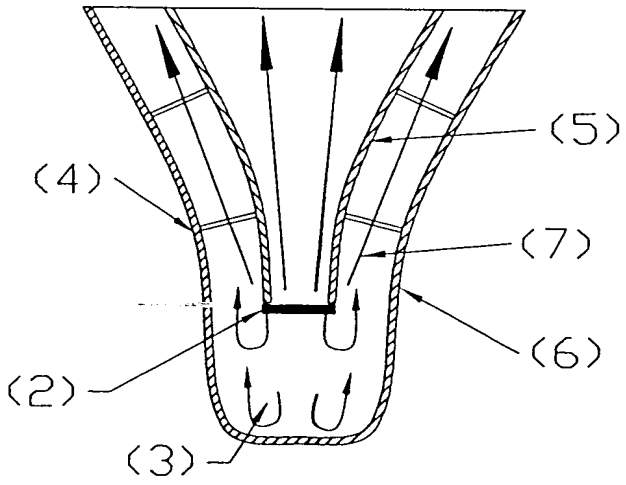

Fig 3

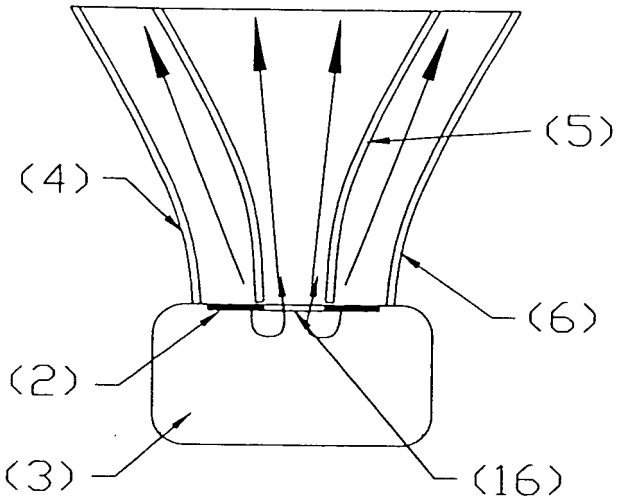

Fig 4

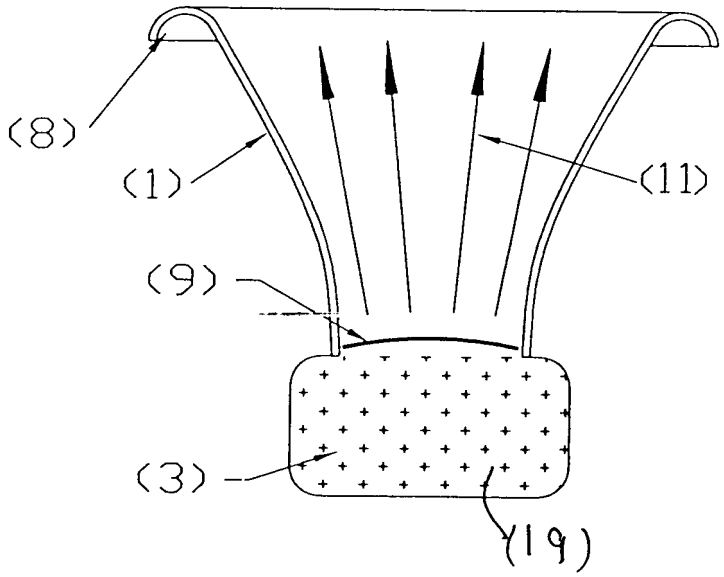

Fig 5

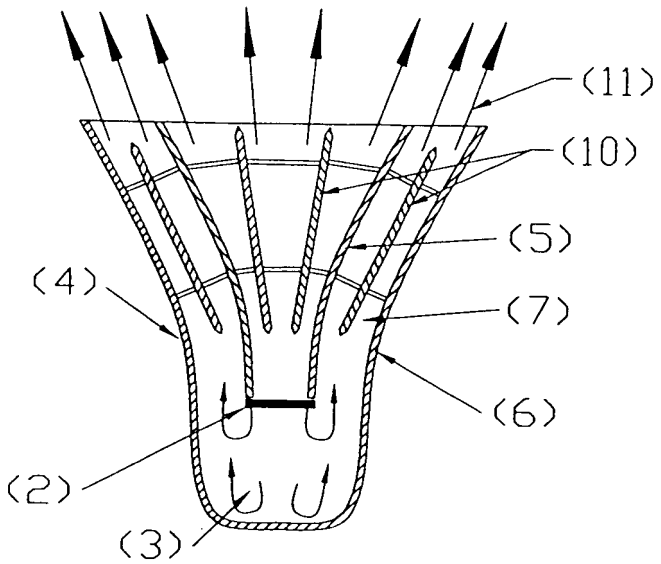

Fig 6

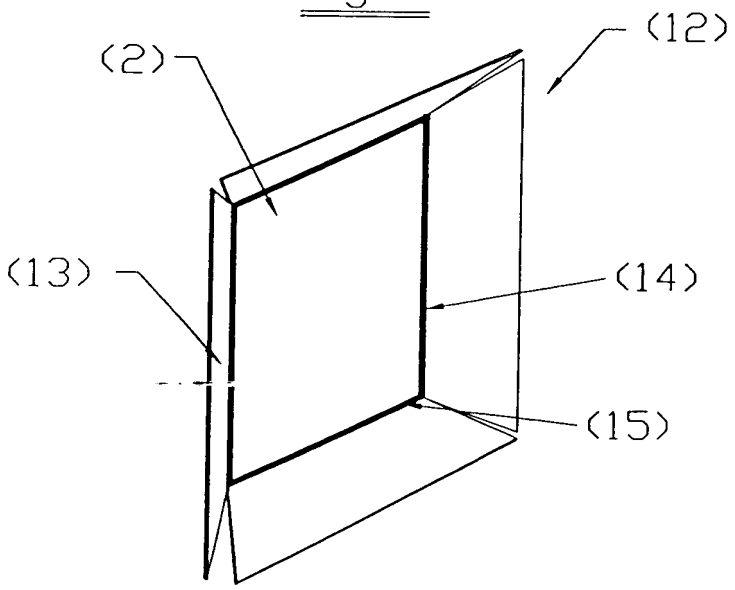

Fig 7.